

**CLAIMS**

1. A method of making molecular sieve catalyst particles, the method comprising the steps of:
  - a) providing a solution or suspension of an aluminum-containing inorganic oxide precursor in a liquid medium;
  - b) combining the solution or suspension of aluminum-containing inorganic oxide precursor with a molecular sieve, and optionally other formulating agents, to form a catalyst formulation slurry;
  - c) aging the catalyst formulation slurry to generate in said slurry a percentage, or increase in said slurry the existing percentage, of aluminum atoms of the aluminum-containing precursor in the form of oligomers having a sharp  $^{27}\text{Al}$  NMR peak at 62-63 ppm; and
  - d) forming molecular sieve catalyst particles from the catalyst formulation slurry.
2. The method of claim 1, wherein the liquid medium is water.
3. The method of claim 1, wherein aging is carried out at a temperature and for a period of time such that at least 5 atom % of the aluminum atoms of the aluminum-containing precursor in the catalyst formulation slurry is in the form of oligomers having between 10 and 75 aluminum atoms per molecule.
4. The method of claim 3, wherein aging is carried out at a temperature and for a period of time such that at least 10 atom % of the aluminum atoms of the aluminum-containing precursor in the catalyst formulation slurry is in the form of oligomers having between 10 and 75 aluminum atoms per molecule.
5. The method of claim 2, wherein at least 6 atom % of the aluminum atoms of the aluminum-containing precursor in the catalyst formulation slurry is in the form of oligomers having a sharp  $^{27}\text{Al}$  NMR peak at 62-63 ppm.

6. The method of claim 2, wherein at least 8 atom % of the aluminum atoms of the aluminum-containing precursor in the catalyst formulation slurry is in the form of oligomers having a sharp  $^{27}\text{Al}$  NMR peak at 62-63 ppm.
7. The method of claim 2, wherein the inorganic oxide precursor comprises an aluminum oxide precursor and a zirconium oxide precursor.
8. The method of claim 2, wherein the inorganic oxide precursor is an aluminum oxide or aluminum-zirconium oxide precursor.
9. The method of claim 2, wherein the inorganic oxide precursor is selected from the group consisting of aluminum chlorohydrate and aluminum-zirconium chlorohydrate.
10. The method of claim 2, wherein aging in step c) takes place by maintaining the catalyst formulation slurry at a temperature of from 0°C to 100°C for a period of at least 2 hours, preferably for a period of at least 4 hours.
11. The method of claim 10, wherein the catalyst formulation slurry is maintained at a temperature of from 15°C to 80°C.
12. The method of claim 11, wherein aging of the catalyst formulation slurry takes place for a period of at least 5 hours, preferably at least 8 hours.
13. The method of claim 2, wherein aging of the catalyst formulation slurry does not take place for more than 24 hours.
14. The method of claim 2, wherein the solution or suspension of inorganic oxide precursor is not aged.

15. The method of claim 2, wherein the solution or suspension of inorganic oxide precursor is maintained at a temperature of from 15°C to 50°C for a period of not more than 4 hours.
16. The method of claim 1, wherein the catalyst formulation slurry further contains a matrix material, preferably a clay, more preferably kaolin clay.
17. The method of claim 1, wherein the molecular sieve is a metalloaluminophosphate molecular sieve.
18. The method of claim 1, wherein the molecular sieve is a silicoaluminophosphate molecular sieve.
19. The method of claim 18, wherein the molecular sieve is selected from SAPO-18, SAPO-34, SAPO-44, intergrown forms thereof, metal-containing forms thereof, and mixtures thereof.
20. The method of claim 1, wherein at least a portion of the molecular sieve used in step b) is provided in the form of uncalcined molecular sieve catalyst particles.
21. The method of claim 2, wherein the catalyst formulation slurry prepared in step b) has a viscosity of from 1.0 to 10.0 Pa-s, preferably of from 1.2 to 9.5 Pa-s, when measured at a temperature between 23°C and 30 °C, using a Brookfield LV viscometer, with a #3 spindle at 10 rpm.
22. The method of claim 1, wherein forming the catalyst particles is performed by spray drying.
23. The method of claim 1, further comprising the step of calcining the molecular sieve catalyst particles.

24. A method of making molecular sieve catalyst particles, the method comprising the steps of:

- a) preparing a solution or suspension of inorganic oxide precursor in a liquid medium;
- b) combining the solution or suspension of inorganic oxide precursor with a molecular sieve, and optionally other formulating agents, to form a catalyst formulation slurry;
- c) aging the suspension of inorganic oxide; and
- d) forming molecular sieve catalyst particles from the catalyst formulation slurry;

wherein said aging is carried out at a temperature and for a duration such that the catalyst formulation slurry has a Relative Binding Efficiency between 1.02 and 1.25.

25. The method of claim 24, wherein the liquid medium is water.

26. The method of claim 25, wherein aging is carried out at a temperature and for a period of time such that the catalyst formulation slurry has a Relative Binding Efficient between 1.02 and 1.2, preferably 1.18, more preferably 1.15.

27. The method of claim 25, wherein the inorganic oxide precursor comprises an aluminum oxide precursor and a zirconium oxide precursor.

28. The method of claim 25, wherein the inorganic oxide precursor is an aluminum oxide or aluminum-zirconium oxide precursor.

29. The method of claim 25, wherein the inorganic oxide precursor is selected from the group consisting of aluminum chlorohydrate and aluminum-zirconium chlorohydrate.

30. The method of claim 25, wherein aging in step c) takes place by maintaining the catalyst formulation slurry at a temperature of from 0°C to 100°C for a period of at least 2 hours, preferably for a period of at least 4 hours.
31. The method of claim 30, wherein the catalyst formulation slurry is maintained at a temperature of from 15°C to 80°C.
32. The method of claim 31, wherein aging of the catalyst formulation slurry takes place for a period of at least 5 hours, preferably at least 8 hours.
33. The method of claim 32, wherein aging of the catalyst formulation slurry does not take place for more than 24 hours.
34. The method of claim 32, wherein the solution or suspension of inorganic oxide precursor is not aged.
35. The method of claim 32, wherein the solution or suspension of inorganic oxide precursor is maintained at a temperature of from 15°C to 50°C for a period of not more than 4 hours.
36. The method of claim 25, wherein the catalyst formulation slurry further contains a matrix material, preferably a clay, more preferably kaolin clay.
37. The method of claim 25, wherein the molecular sieve is a metalloaluminophosphate molecular sieve.
38. The method of claim 25, wherein the molecular sieve is a silicoaluminophosphate molecular sieve.

39. The method of claim 38, wherein the molecular sieve is selected from SAPO-18, SAPO-34, SAPO-44, intergrown forms thereof, metal-containing forms thereof, and mixtures thereof.

40. The method of claim 25, wherein at least a portion of the molecular sieve used in step b) is provided in the form of uncalcined molecular sieve catalyst particles.

41. The method of claim 25, wherein the catalyst formulation slurry prepared in step b) has a viscosity of from 1.0 to 10.0 Pa-s, preferably of from 1.2 to 9.5 Pa-s, when measured at a temperature between 23°C and 30 °C, using a Brookfield LV viscometer, with a #3 spindle at 10 rpm.

42. The method of claim 24, wherein forming the catalyst particles is performed by spray drying.

43. The method of claim 24, further comprising the step of calcining the molecular sieve catalyst particles.

44. A method of making molecular sieve catalyst particles, the method comprising the steps of:

- a) preparing a solution or suspension of inorganic oxide precursor in a liquid medium;
- b) combining the solution or suspension of inorganic oxide precursor with a molecular sieve, and optionally other formulating agents, to form a catalyst formulation slurry;
- c) aging the catalyst formulation slurry; and
- d) forming molecular sieve catalyst particles from the catalyst formulation slurry;

wherein said aging is carried out at a temperature and for a duration such that the molecular sieve catalyst particles obtained after step d) have an ARI value of less than 1.0.

45. The method of claim 44, wherein the molecular sieve catalyst particles obtained after step d) have an ARI of less than 0.5.

46. The method of claim 44, wherein the liquid medium is water.

47. The method of claim 46, wherein the inorganic oxide precursor comprises an aluminum oxide precursor and a zirconium oxide precursor.

48. The method of claim 46, wherein the inorganic oxide precursor is an aluminum oxide or aluminum-zirconium oxide precursor.

49. The method of claim 46, wherein the inorganic oxide precursor is selected from the group consisting of aluminum chlorohydrate and aluminum-zirconium chlorohydrate.

50. The method of claim 46, wherein aging in step c) takes place by maintaining the catalyst formulation slurry at a temperature of from 0°C to 100°C for a period of at least 2 hours, preferably for a period of at least 4 hours.

51. The method of claim 50, wherein the catalyst formulation slurry is maintained at a temperature of from 15°C to 80°C.

52. The method of claim 51, wherein aging of the catalyst formulation slurry takes place for a period of at least 5 hours, preferably at least 8 hours.

53. The method of claim 46, wherein aging of the catalyst formulation slurry does not take place for more than 24 hours.

54. The method of claim 46, wherein the solution or suspension of inorganic oxide precursor is not aged.
55. The method of claim 46, wherein the solution or suspension of inorganic oxide precursor is maintained at a temperature of from 15°C to 50°C for a period of not more than 4 hours.
56. The method of claim 44, wherein the catalyst formulation slurry further contains a matrix material, preferably a clay, more preferably kaolin clay.
57. The method of claim 44, wherein the molecular sieve is a metalloaluminophosphate molecular sieve.
58. The method of claim 44, wherein the molecular sieve is a silicoaluminophosphate molecular sieve.
59. The method of claim 58, wherein the molecular sieve is selected from SAPO-18, SAPO-34, SAPO-44, intergrown forms thereof, metal-containing forms thereof, and mixtures thereof.
60. The method of claim 44, wherein at least a portion of the molecular sieve used in step b) is provided in the form of uncalcined molecular sieve catalyst particles.
61. The method of claim 46, wherein the catalyst formulation slurry prepared in step b) has a viscosity of from 1.0 to 10.0 Pa-s, preferably of from 1.2 to 9.5 Pa-s, when measured at a temperature between 23°C and 30 °C, using a Brookfield LV viscometer, with a #3 spindle at 10 rpm.
62. The method of claim 44, wherein forming the catalyst particles is performed by spray drying.



63. The method of claim 44, further comprising the step of calcining the molecular sieve catalyst particles.
64. A catalyst formulation slurry comprising
- (a) molecular sieve particles;
  - (b) a hydrolyzed form of aluminum oxide;
  - (c) water;
  - (d) optionally, matrix particles;
- wherein at least 5 atom %, preferably at least 6 atom %, more preferably at least 10 atom % of the hydrolyzed form of aluminum oxide is in the form of oligomers having a sharp  $^{27}\text{Al}$  NMR peak at 62-63 ppm
65. The catalyst formulation slurry of claim 64, further comprising a hydrolyzed form of zirconium oxide.
66. The catalyst formulation slurry of claim 65 wherein the molecular sieve is a metalloaluminophosphate molecular sieve.
67. The catalyst formulation slurry of claim 65 wherein the molecular sieve is a silicoaluminophosphate molecular sieve.
68. The catalyst formulation slurry of claim 65, wherein the molecular sieve is selected from SAPO-18, SAPO-34, SAPO-44, intergrown forms thereof, metal-containing forms thereof and mixtures thereof.
69. The catalyst formulation slurry of claim 65, wherein the catalyst formulation slurry has a viscosity of from 1.0 to 10.0 Pa-s, preferably of from 1.2 to 9.5 Pa-s, when measured at a temperature between 23°C and 30 °C, using a Brookfield LV viscometer, with a #3 spindle at 10 rpm.
70. A molecular sieve catalyst comprising

- a silicoaluminophosphate molecular sieve;
- aluminum oxide;
- zirconium oxide; and
- a clay;

wherein the catalyst has an ARI of less than 1.0, preferably less than 0.7, more preferably less than 0.5, most preferably less than 0.2.

71. The molecular sieve catalyst of claim 70, having an aluminum to zirconium atomic ratio of from 0.1 to 20, preferably of from 2.0 to 15, more preferably of from 3.0 to 10.0.

72. The molecular sieve catalyst of claim 70 wherein the molecular sieve is a metalloaluminophosphate molecular sieve.

73. The molecular sieve catalyst of claim 70, wherein the molecular sieve is a silicoaluminophosphate molecular sieve.

74. The molecular sieve catalyst of claim 70, wherein the molecular sieve is selected from SAPO-18, SAPO-34, SAPO-44, metal-containing forms thereof and mixtures thereof.

75. The molecular sieve catalyst of claim 70, wherein the amount of molecular sieve within the catalyst is from 2 wt % to 85 wt %, preferably of from 20 wt% to 80 wt%.

76. The molecular sieve catalyst of claim 70, wherein the combined total amount of aluminum oxide and zirconium oxide within the catalyst is from 4 wt % to 30 wt %.

77. The molecular sieve catalyst of claim 70, wherein the particle size distribution of the catalyst is 15-200 microns.

78. A process for the manufacture of olefins from a feedstock, wherein the catalyst of claim 70 is contacted with a feedstock under conditions to convert the feedstock to olefins.

79. The process of claim 78, wherein the feedstock comprises one or more oxygenated hydrocarbons.

80. The process of claim 79, wherein the feedstock comprises methanol.

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81/ ~~82.~~ A method of making molecular sieve catalyst particles, the method comprising the steps of:

- a) providing a solution or suspension of inorganic oxide precursor in a liquid medium;
- b) aging the solution or suspension of inorganic oxide precursor,
- c) combining the solution or suspension of inorganic oxide precursor with molecular sieve, and optionally other formulating agents, to form a catalyst formulation slurry;
- d) forming molecular sieve catalyst particles from the catalyst formulation slurry;

wherein aging is carried out at a temperature and for a duration such that the molecular sieve catalyst particles obtained after step d) have an ARI value of less than 1.0.

82/ ~~83.~~ The method of claim 82, wherein the liquid medium is water.

83/ ~~84.~~ The method of claim 82, wherein the molecular sieve catalyst particles obtained after step d) have an ARI value of less than 0.5.

84/ ~~85.~~ The method of claim 82, wherein the catalyst formulation slurry is maintained at a temperature of from 15°C to 50°C for a period of not more than 12

hours, preferably not more than 8 hours, before forming the molecular sieve catalyst particles in step d).

85 ~~86~~. The method of claim 82, wherein the inorganic oxide precursor comprises an aluminum oxide precursor and a zirconium oxide precursor.

86 ~~87~~. The method of claim 82, wherein the inorganic oxide precursor is an aluminum oxide or aluminum-zirconium oxide precursor.

R126 87 ~~88~~. The method of claim 87, wherein the inorganic oxide precursor is selected from the group consisting of aluminum chlorohydrate and aluminum-zirconium chlorohydrate, and mixtures thereof.

88 ~~89~~. The method of claim 88, wherein aging of the inorganic oxide precursor solution or suspension is carried out by maintaining the solution or suspension of inorganic oxide at a temperature of from 10°C to 80°C for a period of at least 1 hours, preferably for a period of at least 1.5 hours, more preferably for a period of at least 2 hours, even more preferably for a period of at least 3 hours, most preferably for a period of at least 4 hours.

89 ~~90~~. The method of claim 89, wherein the temperature at which the solution or suspension of inorganic oxide is maintained is of from 15°C to 70°C, preferably of from 20°C to 50°C.

90 ~~91~~. The method of claim 90, wherein aging takes place for a period of at least 5 hours, preferably at least 12 hours, more preferably at least 24 hours, most preferably at least 48 hours.

91 ~~92~~. The method of claim 82, wherein the catalyst formulation slurry further contains a matrix material, preferably a clay, more preferably kaolin clay.

92 ~~93~~. The method of claim 82, wherein the catalyst formulation slurry has a viscosity of from 1.0 to 10.0 Pa-s, preferably of from 1.2 to 9.5 Pa-s, when measured at a temperature between 23°C and 30 °C, using a Brookfield LV viscometer, with a #3 spindle at 10 rpm.

93 ~~94~~. The method of claim 82, wherein the molecular sieve is a metalloaluminophosphate molecular sieve.

94 ~~95~~. The method of claim 94, wherein the molecular sieve is a silicoaluminophosphate molecular sieve.

R126 95 ~~96~~. The method of claim 95, wherein the molecular sieve is selected from SAPO-18, SAPO-34, SAPO-44, intergrown forms thereof, metal-containing forms thereof and mixtures thereof.

96 ~~97~~. The method of claim 82, wherein at least a portion of the molecular sieve used in step c) is provided in the form of uncalcined molecular sieve catalyst particles.

97 ~~98~~. The method of claim 82, wherein forming the catalyst particles is performed by spray drying.

98 ~~99~~. The method of claim 82, further comprising the step of calcining the molecular sieve catalyst particles.

99 ~~100~~. A process for converting a feedstock comprising organic compounds to conversion product which comprises contacting said feedstock with a catalyst comprising an active form of the molecular sieve catalyst particles prepared by the process of Claim 1.

~~100~~ 101. The process of claim 100, wherein said feedstock comprises oxygenates and said conversion product comprises one or more olefins.

02/26 ~~101~~ 102. A process for converting a feedstock comprising organic compounds to conversion product which comprises contacting said feedstock with an active form of the molecular sieve catalyst of Claim 70.

~~102~~ 103. The process of claim 102, wherein said feedstock comprises oxygenates and said conversion product comprises one or more olefins.